The Henderson Mine as an Underground Laboratory

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Abstract. The Henderson Mine, operated by the Climax Molybdenum Company, is one of two sites under consideration by NSF to host a Deep Underground Science and Engineering Laboratory (DUSEL). Henderson, in the Rocky Mountains west of Denver, is an active molybdenum mine with large access shafts and high rock processing and removal capability.

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THE SCIENTIFIC CASE FOR AN UNDERGROUND LABORATORY

Scientific interest in a general-purpose deep underground lab in the United States has existed since at least the early 1980s[2]. A multidisciplinary underground science community has developed, consisting of astronomers, biologists, geologists, and physicists. The science underground consists of studies of the biological and geological environment iteslf, as well as physics and neutrino astronomy experiments that demand a low background environment.

Physics topics at DUSEL will range widely. Major proposed nuclear and high energy physics efforts will include neutrinoless double-beta decay and direct detection of dark matter. A large experiment to search for proton decay and study neutrino oscillations may also be mounted, perhaps paired with a long-baseline neutrino beam form Fermilab or Brookhaven. Low-energy solar neutrino astrophysics may also be an area of research at the lab. The lab is expected to include a low-background counting facility.

THE HENDERSON MINE

The Henderson Mine is a high-volume mine on the world's second largest known molybdenum deposit. The mine is owned and operated by the Climax Molybdenum Company, a subsidiary of Phelps Dodge. The mine was built in the 1970s and extensively modernized in the late 1990s, making it one of the most technologically advanced hard rock mines in operation.

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[1] `http://ale.physics.sunysb.edu/husep/`
[2] M. Nieto *et al.*,, "Workshop on Science Underground," Los Alamos, Sept. 1982, *AIP Conf. Proc.* **96**

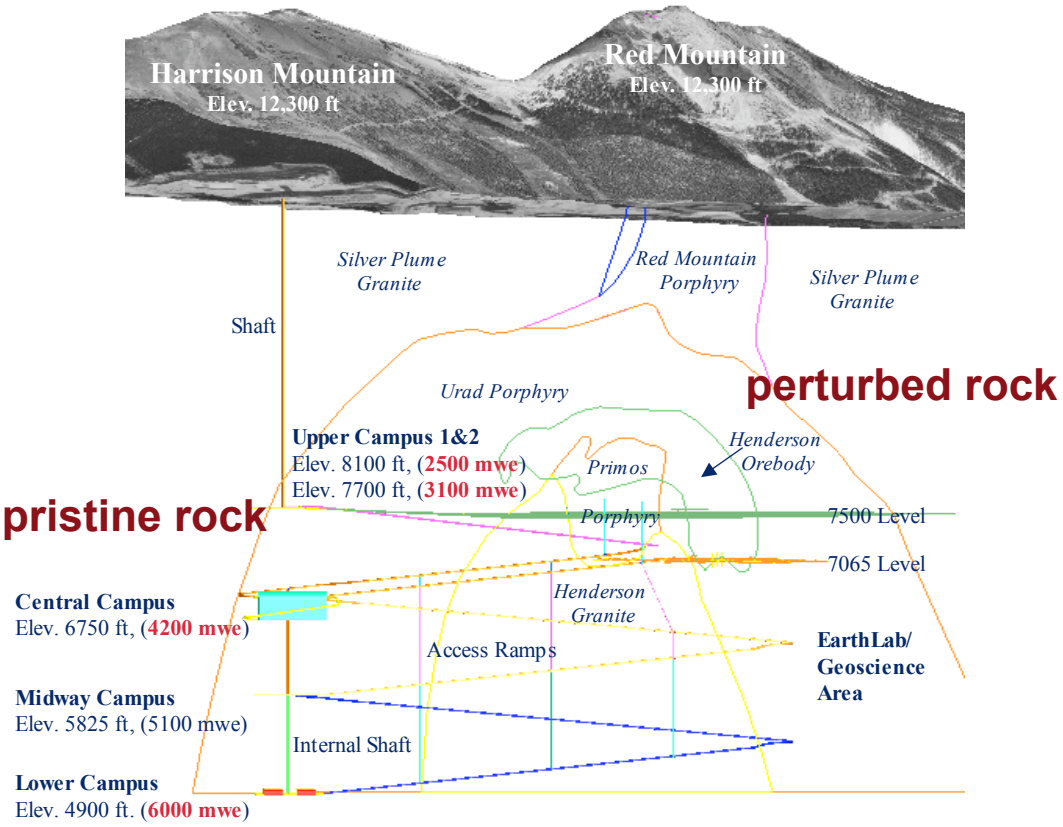

FIGURE 1. Conceptual layout of the proposed DUSEL campus at the Henderson Mine. The shaft and excavations at the 8100 and 7700 levels exist.

Henderson is located in the Rocky Mountains of north-central Colorado, about fifty miles west of Denver and immediately east of the Continental Divide. Access to the mine is via an Interstate highway from Denver, followed by approximately ten miles on a two-lane U. S. highway. The roads provide access to major ski areas, and are therefore well-maintained and cleared in winter. Oscillation baselines for potential neutrino beams from Fermilab and Brookhaven would be 1497 and 2766 km respectively.

The Henderson site contains two adjacent mountain peaks, each 12,300 feet high. The active mining is occurring in Red Mountain, and the lab will be built under Harrison Mountain. The mine and the lab will share the 28-foot access shaft, which is large enough to bring a standard shipping container underground. The cage has a capacity of 50 tons, and heavier loads could be brought in with the cage removed. The mine has spare rock removal capacity: rock is removed via a high-speed conveyor belt to a remote tailings site owned by Climax. After mining operations cease in an expected 15–20 years, the conveyor could be converted to a horizontal access tunnel.

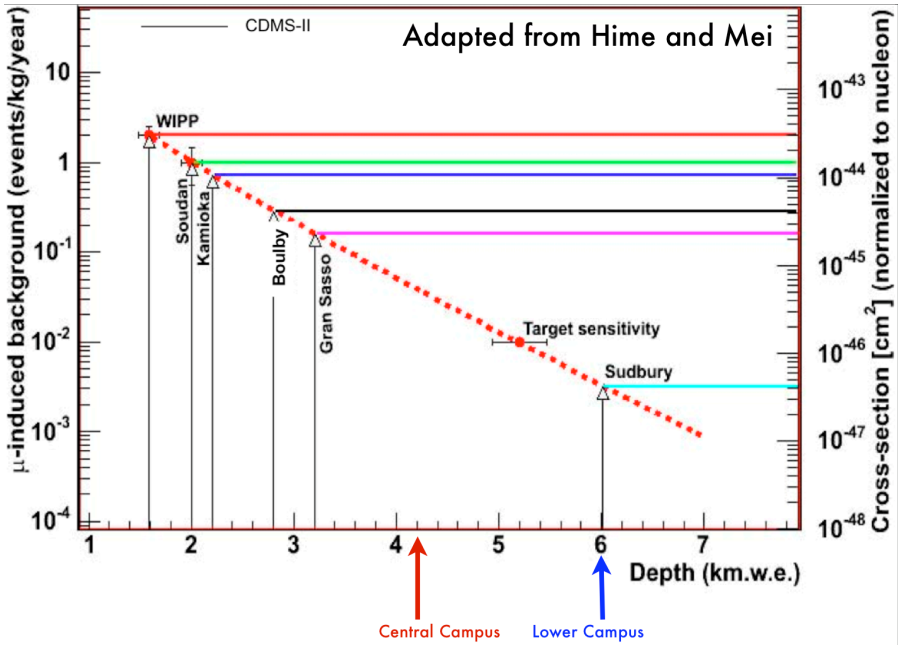

FIGURE 2. Sample background requirements for dark matter detection experiments. Figure adapted from A. Hime and D. Mei, to be published. The background levels at the Henderson Central and Lower Campuses are shown.

HENDERSON DUSEL

A preliminary layout of the laboratory is shown in Fig. 1. The lab would be built in stages, starting with an Upper Campus at elevations of 8100 and 7700 feet above sea level, with overburden of 2500 and 3100 m H_2O equiv. (mwe). These areas are already available, requiring only modest renovations. The earlier experiments would be located in a new Central Campus, where several caverns would be excavated at an elevation of 6750 feet (4200 mwe). This would be the area where a megaton-scale multipurpose detector could be located. A Lower Campus at 4900 feet elevation (6000 mwe) will be reached approximately four years after initial groundbreaking. This area, with depth comparable to Sudbury, will house experiments with particularly low background requirements, such as ton-scale dark matter detector and future-generation double beta decay searches. A core drill to the site of the Central Campus revealed very favorable conditions for excavation and laboratory construction; a second core drill, to the Lower Campus site, will be performed in March 2006.

Figure 2 shows the depth of the proposed Central and Lower campuses along with other current and proposed underground laboratories and desired background levels for (as an example) dark matter experiments.

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